

## VOLKMANN'S ISCHEMIC CONTRACTURE – A CASE REPORT

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### ABSTRACT

*This case report describes about a case of a 13 year old male child with Volkmann's Ischemic Contracture of Left Forearm following a fall on the granite stone. This case demonstrates the results and follow up of conservative Physiotherapy management with appropriate bracing revised on time to time basis as a part of Multidisciplinary approach. During the continuous follow-up of 8 months under Physiotherapy, the subject has shown functional recovery in terms of range of motion, flexibility and extensibility of shortened tissues, scar tissue reduction, grip strength, prehension and precision activities on hand.*

*Mode of management may be conservative or surgical, Physiotherapists can provide suitable interventions in this kind of cases as part of multidisciplinary teams. The physiotherapist will have their role to work in analogy with the goal of physician and surgeon with acceptable scientific evidence so that the surgeon will have more chances to delay or stop the subject from exposing to surgeries like tendon transfers, Neurotisations, lengthening and fasciotomies if the subject is improving in the functional domain with Physiotherapy management.*

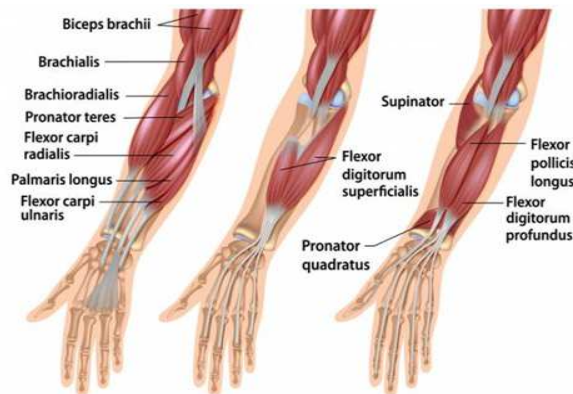
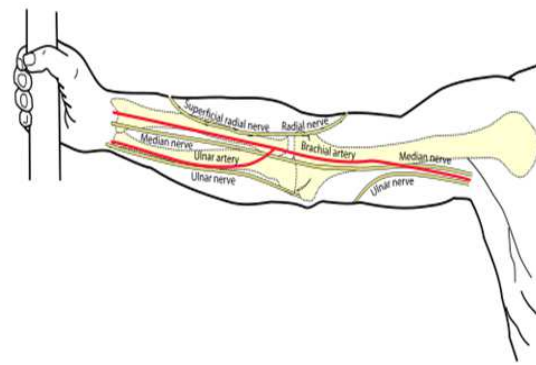
**KEYWORDS:** Physiotherapy, Volkmann's Ischemic Contracture, Hand Function, Forearm Contracture, Scar Management & Flexibility of Hand and Functional Grip

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### INTRODUCTION

Forearm is the region between Elbow and wrist, it has two long bones (Radius and Ulna), and the forearm consists of two compartments i.e anterior and posterior compartments. Flexors of fingers are located anteriorly and extensors posteriorly, the anterior compartment of muscles of the forearm may be divided into superficial & deep (figure 1). Superficial muscles are pronator teres, flexor carpi radialis, palmaris longus, flexor carpi ulnaris and flexor digitorum superficialis. Deep muscles are flexor digitorum profundus, flexor pollicis longus, pronator quadratus. It has two arteries (Radial and Ulnar) and three nerves (Median, Radial and Ulnar) (figure 2). Median Nerve innervates pronator teres, flexor carpi radialis, palmaris longus, and flexor digitorum superficialis. Lateral half of flexor digitorum profundus, flexor pollicis longus, pronator quadratus are innervated by anterior interosseous nerve (branch of median nerve). Medial half of flexor digitorum profundus, Flexor carpi ulnaris is innervated by ulnar nerve.

Radial artery, ulnar artery and their branches provide blood supply to forearm, these are terminal branches of brachial artery, located on anterior aspect of forearm. Radial artery lies, superficially in front of the distal end of the radius, between the tendons of the brachioradialis and flexor carpi radialis and ulnar artery is the main blood vessel for medial aspect of forearm it is palpable on the anterior and medial aspect of the wrist.

**Figure 1: Forearm Muscles -Anterior Compartment****Figure 2: Arteries and Nerves of Forearm**

The term Volkmann ischemic contracture was described by Richard von Volkmann in 1875 (1). Volkmann's contracture is the contraction of the fingers and sometimes of the wrist, or of analogous parts of the foot, with loss of power, after severe injury or improper use of a tourniquet or cast in the region of the elbow (2). Ischemic contracture is referred as muscular contracture and degeneration due to interference with the circulation due to pressure or to injury or cold. A serious, persistent flexion contraction of the forearm and hand caused by ischemia. A pressure or crushing injury in the region of the elbow usually precedes this condition, and pressure from a cast or tight bandage about the elbow is a common cause (Richard von Volkmann, German surgeon, 1830-1889).

The incidence of Volkmann's contracture is low and it is considered as a rare condition with an incidence of 0.5%. One study reported as 0.105% incidence of all orthopaedic cases, most of them lived in rural areas (3). Fractures of upper limb bones might cause Injury to major vessels, obstruction to blood supply. Obstruction to brachial artery or its branches might lead to ischemia, eventually necrosis, fibrosis and shortening of flexor compartment muscles depending on the vessel involved. Shortening of these muscles results in a claw-like deformity of the hand and fingers with restricted range of motion, pain and functional variation. This condition may affect the vascular supply and function of nerves.

Many cases need surgical, interventions like fasciotomies, tendon transfers (4) for correction of deformity and tightness. All cases need proper exercise regimen for physiological recovery of muscle, nerve and function.

## CASE REPORT

A 13 year old male child fell down on a granite stone with body weight on left forearm on 18<sup>th</sup> April, 2017, started having unbearable pain in few minutes and realised that he was unable to move his left elbow and wrist except little movement in the fingers. After some time his brother took the boy to the nearest diagnostic centre to have an x-ray where radiography technician noticed that both the bones fractured in the left forearm (Figure 3) and suggested to have treatment.

He was taken to a local bone setter for treatment on the same day, bone setter applied wooden sticks to the injured forearm and secured with a crepe bandage (Figure 4). The pain subsided after half an hour of crepe application and was pain free for almost half an hour and again pain initiated with more intensity. Gradually the pain subsided and was doing the finger movements on bandage. After 6 days (i.e. on 24<sup>th</sup> April 2017) he had severe pain and unusual sensation in the forearm inside the bandage and went back to the bone setter for review, he opened the bandage and found two open wounds where wooden sticks pierced the skin and went inside the forearm region on radial and another ulnar aspect (figure 5).



**Figure 3: X Ray of Left Forearm**



**Figure 4: Crepe Application**



**Figure 5: Wooden Sticks Pierced Inside the Skin**

On the advice of bonesetter they visited the nearest clinic for management of wounds, wounds were treated with topical applications (figure 6) for 8 days, gradually wounds became infected and they noticed forearm was becoming bluish(Figure 7). They went to an another clinic for treatment and for daily dressings, wound was responding well and met an orthopaedic surgeon on 6<sup>th</sup> May 2017, had an X ray (Figure 8). They were informed that bone union is good, muscles became shorter and advised to meet a plastic surgeon for further management.



**Figure 6: Topical Application of Ointment**



**Figure 7: Bluish Discoloration of Wound**



**Figure 8: 2nd X Ray of Left Forearm**

## CLINICAL EXAMINATION SUMMARY

From 18<sup>th</sup> April 2017 to 6<sup>th</sup> May 2017, they don't have any clinical reports or investigation reports except X rays which shows both the bone fractured in the left forearm. They came to Nizam's Institute of Medical sciences, Hyderabad for further management. After Orthopaedic, the surgeon diagnosed it as Volkman's ischemic contracture, on 17<sup>th</sup> June EMG (electro myography) & nerve conduction studies were done to see the status of the nerves of the forearm. Concentric EMG of left Abductor pollicis brevis (APB) and the Flexor digitorum showed the spontaneous activity in the form of fibrillations with no recruitable MUPs. EMG of left EDC extensor digitorum communes showed spontaneous activity in the form of fibrillations with few recruitable MUPs. EMG of biceps, Flexor pollicis longus(FPL) and Flexor carpi ulnaris(FCU) muscles showed no spontaneous activity with Motor unit potentials of 1.0- 1.2  $\mu$ v of amplitude and 5-6 m.sec of duration with normal recruitment. Motor conductions of left median and ulnar were not recorded at wrist. On orthodromic (Digit II and V) Sensory nerve conduction study, sensory potentials not recorded. Features suggestive of multiple nerve injuries, median nerve distal to branch to PL, Ulnar nerve distal to FCU, radial nerve distal to brachio radialis branch.

After having consultations from a Plastic surgeon following Orthopaedics and Neurology, they were referred to the Department of Physiotherapy for further management. Physical examination revealed weakness, sensory changes, multiple joints tightness and shortening of the forearm muscles, wrist flexion 50°flexion to 15° extension, 35°degrees of

supination to 45° of pronation. Metacarpophalangeal joint flexion limited to 90 degrees.

Hypersensitivity of whole hand below the wrist, predominantly lateral 4 fingers, Open wounds is present on the lateral and medial sides of the forearm. Restricted wrist joint radial deviation. Precision, prehension, grip strength and pinch strength are weak. Power and gross motor function of the wrist and fingers are affected. He was unable to perform prehension activities like opposition from thumb to one digit, pinch activities like lateral prehension (Ex: key holding), tip to tip and a three jaw chuck are lost. FDS, FDP and lumbricals are weak. Unable to Hook & grasp 1/4" diameter rod, can't do spherical grasp on 1/2" diameter cone, unable to pick up ball pins and seeds of 1/4" diameter. On timed functional activity testing he took 29 seconds to Screw 1/2" nut & bolt and for unscrewing 1/2" it is 24 seconds. Removing the jar lid of 1 1/2" and 3" diameter is not possible for him.

### **COURSE OF TREATMENT IN THE DEPARTMENT OF PHYSIOTHERAPY**

Subject's parents were informed about the need of regular follow-up and with their consent, treatment was initiated with the following goals: Stable environment for wound healing, Functional joint mobility, and Muscle length and tension restoration, Reduction of hypersensitivity of hand, Handgrip is strengthening, Finger dexterity and hand function promotion.

Physiotherapy department as the part of multidisciplinary teams, worked in coordination with plastic surgery, orthopaedics and neurology maintained follow up regularly. Wound debridement was done and aseptic environment is provided with regular dressing in the plastic surgery department, topical application of Mupirocin (T.Bact 2%) gel was given to apply locally. Mupirocin topical is used in the treatment of bacterial infections. This is an antibiotic, it kills bacteria by destroying the bacterial cell membrane.

As the wound started healing (figure 9), the subject was encouraged towards mobility and flexibility in order to prevent further shortening of muscles, fascia tightness and joint restrictions. Steps initiated to loosen the tough scar tissue on forearm region (figure 10). Passive movements, joint glides, muscle and capsular stretches were given to left radio-ulnar joints, wrist, MCP, PIP, DIP joints and thumb along with proximal, and distal carpal mobility (5 days a week). Since tendons were intact and there is no damage to the attachment of muscles, flexors of wrist joint were subjected to sustained and intense stretching to the level of resistance barrier from muscle and fascia. Strengthening of forearm muscles using graded weights, grip strengthening exercises using physio-balls, therapeutic putty, D grip and springs (figure 11) were used as tools for resistance training of hand muscles. Sensory adaptation and sensory re-education methods were applied to sensitive hand using different textures (soft to hard; ex: cotton, cloth, cardboard weight adaptation) to reduce the hypersensitivity.



**Figure 9: Wound Healing**



**Figure 10: Wound Scar**



**Figure 11: 'D' Spring**



Sensory re-education initiated with a soft brush from distal to proximal as the adaptation with the very soft cloth is satisfactory, active supination and pronation movements encouraged with wrist roll cum supination and pronation exerciser (figure 12). Stretching, resistance exercises, active and passive joint mobility for wrist and fingers continued. Methods like scar kneading, rolling are given for softening the scar tissue. Ultrasound has thermal effects on tissues, ultrasonic beam produces compressions and rarefactions, this vibrant movement inside the skin, produces local tissue heating and improves the tissue viscoelasticity and extensibility which works on the scar tissue and fibrosis. High density ultrasound was used for scar tissue management. Ultrasound around the scar tissue was given weekly thrice on alternative days.

Along with manual methods of Scar tissue mobility, scar tissue taping was given, Kinesio tex gold finger print tape was applied twice a week over the scar, with a strip size of 1.5 to 2 cm in perpendicular direction, overlapping method, with 30% to 40% stretch (figure 13), during initial application he could not tolerate tape for longer duration, had complaints of irritation, mild itching sensation around the scar. With the reduction of Tape tension to 25% gave good tolerance, gradually he was tolerating up to 40% within few weeks.



**Figure 12: Wrist Roll cum Supination and Pronation Exerciser**



**Figure 13: Scar Tissue Taping**

The muscle length tension relationship was maintained with appropriate splinting. Dynamic cock-up splint was given to maintain the wrist in extended position, with continuous stretch force on finger flexors. Joint mobilisation, stretching of long and short flexors continued, to have sustained long flexor stretch "Turn buckle" splint applied to forearm. Gradually wrist joint was passively kept in neutral to extension by timely modification of splints in association with orthotist (figure 14). The small muscles of the hand became a major concern as the functionality is improving. Interossei, lumbricals, intrinsic muscles of hand, thenar and hypothenar muscles function was improved with active use of those muscles by hand function training tools like Velcro straps, Nut & bolt platform, Pegboards, lock and key hand gym, hand exercise board with hook and loop fasteners, exercises with hand exerciser with spring, peg board exercises, training for screwing and unscrewing, kinetic sand for training prehension and precision movements (figure 15).



**Figure 14: Wrist Roll cum Supination and Pronation Exerciser**



**Figure 15: Nut & Bolt, Kinetic Sand, Velcro**

## SUMMARY

Most of the Volkmann's ischemia cases reported following tight external splintage treated by the bonesetters, severity of contractures has direct relation with extent of nerve & muscle involvement, sensory recovery will be faster than motor recovery (5). This subject was in continuous follow-up from June 2017 to February 2018(8months), subject had 5 days a week sessions for 4 months and later on weekly twice in the home exercise programme. His programme was planned based on the individual needs and include many methods directed to 1) mobility of the elbow, proximal and distal radio ulnar joints, radio carpal, inter carpal, carpometacarpal, inter phalangeal joints. 2) Flexibility of muscle, fascia and joint capsules. 3) Maintaining aseptic environment for wound healing. 4) Scar tissue management. 5) Strengthening of forearm and finger muscles 6) Finger dexterity, agility training. 7) Desensitization and sensory re-education. 8) Functional retraining.



**Figure 16**

Joint mobility was treated with graded joint distraction, glides, slides in the plane of the joint and the correct direction which are the key elements of accessory movements of joint to have stable dynamic mobility. Soft tissues and capsular structures were placed in optimal stretch position in order to have good length tension for functional training. An unwanted stretch of wound surface is avoided to allow healing process. Hypertrophic hard scar tissue was subjected to soft tissue manipulation and taping, which could have helped in making scar flexible with there organisation of collagen extensibility. Weak and atrophied muscles of forearm muscles responded well to strengthening exercises with various resistance tools. Dexterity and agility and functional training gave good output for the boy.

At the end of 8<sup>th</sup> month he had no problem with prehension activities which indicates that his thenar muscles and opponens pollicis have taken up the role and all other intrinsic muscles are considerably functional, since his FDP and FDS are still weak his tip to tip and hook grasp, still need improvement. Spherical grasp on 1/2" diameter cone, picking up ball pins and seeds of 1/4" diameter is another fine movement area needs to be developed. On timed functional activity testing he showed 40% improvement in Screwing and for unscrewing 1/2" nut & bolt. Removing the jar lid of 1 1/2" and 3" diameter is not possible for him in the initial period, but after gaining grip, prehension and precision he can do it with less effort. Though the boy has shown improvement in many areas of hand function there is further scope for improvement to achieve full function of the forearm.

## CONCLUSIONS

Cases like Volkman's ischemic contracture with multiple nerve involvement and adverse events like pressure wounds caused by tight external splint age needs multidisciplinary team work with common vision and goals, and regular follow-up for longer duration. Efficient outcome always depends on initial examination and identification of potential causes and selection of relevant therapeutic measures as curative steps (6). The usual time per session was more than 45 minutes and weekly 5 days. The common follow-up period for these cases is 6-8 months with regular Physiotherapy.

Mode of management may be conservative or surgical, Physiotherapists can provide suitable interventions to this kind of cases as a part of multidisciplinary teams. Physiotherapists will have their role to work in analogy with the goal of the physician and surgeon with acceptable scientific evidence so that the surgeon will have more chances to delay or stop the subject from exposing to surgeries like tendon transfers, Neurotisations, lengthening and fasciotomies if the subject is improving in the functional domain with Physiotherapy management.

## DECLARATION

This article has been neither published nor submitted for publication, in whole or in part, either in a serial, professional journal or as a part in a book which is formally published and made available to the public.

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